DOCUMENT RESUME

ED 028 454 CG 003 702

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School Achievement and Personality. Description of School Achievement in Terms of Ability, Trait, Situational and Background Variables. I: Design and Hypotheses; IV: Results and Discussion.

University of Helsinki (Finland). Inst. of Education.
Pub Date Oct 68
Note-48p.
EDRS Price MF-$0.25 HC-$2.50
Descriptors-*Academic Achievement, Attitudes, *Individual Characteristics, Intelligence, Interpersonal Relationship, *Personality, Psychomotor Skills, Siblings, Social Status, *Student Characteristics
Identifiers-Helsinki, Finland

This monograph, done in Helsinki, Finland, contains the first and fourth sections dealing with design, hypotheses, results, and discussion, describing school achievement in terms of ability, trait, situational, and background variables. The report (1) investigates the structure of school achievement, (2) describes school achievement in terms of selected personality variables, and (3) applies multidimensional statistical operations in situations where it is desirable to reduce the number of dimensions and to describe a set of dependent variables in terms of a set of independent variables in a single operation. Subjects were school pupils, years seven and eight (184 girls and 150 boys). Sex and performance constancy differences were found relating intelligence to achievement. Several significant correlations were found between dexterity and achievement variables, and again with sex differences. No hypotheses were advanced relating persuasibility to achievement, although small interrelations were demonstrated. Results on teacher ratings were mixed and equivocal. Attitudes were shown to be related to achievement variables, as were several sociometric variables. Relationships between variables of social status and achievement, and between sibling number and achievement were mixed, and differed between sexes. (BP)

ED028454

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RESEARCH BULLETIN

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No. 21
October 1968

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I: Design and Hypotheses
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C8 003102

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K. J. Gummerus Osakeyhtiö
Jyväskylä 1968

Part I: Design and Hypotheses

PREFACE

As this study goes to press I wish to express my most sincere thanks to Professor Matti Koskenniemi, who gave me guidance in the design of the study and in several details, and whose comments on the manuscript of the study were of great value.

I also wish to thank Associate Professor R. Olavi Viitamäki, who read both the Finnish manuscript and the English translation of it and gave me valuable advice without stint.

I had the opportunity to discuss numerous details of my work with Professor O. K. Kyöstiö, Dr. Veikko Heinonen and Mr. Olavi Alikoski, Lic. Phil. For this opportunity I wish to express my thanks.

Professor Seppo Mustonen read the part of my study that is concerned with transformation analysis. My thanks are due to him for his help.

I had the opportunity to discuss the multidimensional operations involved in my study with Dr. Touko Markkanen, Lecturer in Psychometrics. I thank him for the help I received.

Mr. Jorma Torppa, M. A., of the Computing Centre of the University of Helsinki, was for several years in charge of the calculation operations necessary for my work. In addition, I had the opportunity to discuss the principles underlying the operations with him. My thanks are due to him and to the other members of the staff of the Computing Centre who participated in carrying out the computer operations necessary for this work.

I also wish to express my thanks to all those at the Finnish Government Computer Centre, at the Institute for Nuclear Physics of the University of Helsinki and at the Computer Centre of the Finnish Cable Works who were responsible for the computer operations carried out in connection with my work.

Mr. Jaakko Railo, M. A., translated the text of this study into English. I thank him for this and especially for his agreeable cooperation and skill in translating the technical terminology.

Mr. Paul Canney of the American Embassy was kind enough to read the English translation and check it linguistically. I wish to express my thanks to him.

Miss Anneli Rusanen, M. A., gave me assistance in preparing the English text for publication. My thanks are due to her for this.

I wish to thank all the teachers who participated in the pupil-trait ratings carried out for this study.

I wish to acknowledge that, at the concluding stage of the study, the University of Helsinki placed computer time at my disposal free of charge. Otherwise I financed the study myself.

Finally, I wish to express my gratitude to Professor Matti Koskenniemi for permission to publish this study in the Research Bulletin series of the Institute of Education of the University of Helsinki.

I dedicate this study to my son, Vesa A. Niskanen.

Helsinki, October 1968

Erkki A. Niskanen

PART I

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1. SUMMARY

The following four parts of my studies on school achievement will be published in succession:

SCHOOL ACHIEVEMENT AND PERSONALITY

Description of School Achievement in Terms of Ability, Trait, Situational and Background Variables

I: Design and Hypotheses

IV: Results and Discussion

These parts are included in this monograph.

II: Operations at the Variable Level

This part is published as No. 22, Research Bulletin, 'Institute of Education, University of Helsinki.

III: Operations at the Factor Level

This part is published as No. 23, Research Bulletin, Institute of Education, University of Helsinki.

The study is concerned with the following three problem areas:

1. investigation of the structure of school achievement
2. description of school achievement in terms of selected personality variables
3. application of multidimensional statistical operations in situations where it is considered desirable to reduce the number of dimensions and to describe a set of dependent variables in terms of a set of independent variables in a single operation.

Citizenship school pupils (compulsory school years 7 and 8) served as subjects in the study; the sample of subjects included 97—87 girls and 80—70 boys.

Part II, Operations at the Variable Level, gives an account of the construction and psychometric properties of the variables.

The information provided by correlation coefficients, factor analyses, congruence coefficients and canonical analyses can be employed to describe school achievement in terms of the personality variables included in the study.

The invariance of the empirical dimensions was studied through a transformation analysis model and by means of the congruence coefficients of factors. The results of a comparative analysis of the dimensions obtained suggest that the girl and boy groups should be treated separately in subsequent operations.

The operations of canonical analysis showed that, in order to reduce the harmful influence of multicollinearity, new solutions concerning the bases of this type of operations should be sought. Also, the interpretation of the results can be simplified by reducing the degree of internal interdependence in the matrices forming the starting-point for canonical analysis.

Preliminary analyses necessary for the factor-level operations are included in Part II.

Part III, Operations at the Factor Level, presents the mathematical and statistical operations at the factor level. This part presents the transformations of groups of variables into factors and describes the analysis models employed.

To bring the description to a more general level, to simplify the research design and to make possible a more concise interpretation of the results, the dependent or school achievement variables and the independent or personality variables were transformed into factor-level variables by means of factor scores.

The information provided by correlation coefficients, factor analyses, congruence coefficients and canonical analyses can be employed to describe school achievement in terms of the personality variables included in the study.

Part IV, Results and Discussion concerns the results of the study and appraises them

against the background of the hypotheses, problems and objectives formulated for the study.

Analysis of the structure of school achievement resulted in five interpretable school achievement factors for each group (girls, boys and a combined group).

The following kinds of variables were employed to describe school achievement.

Ability variables: intelligence (14 factor tests and the general intelligence level as rated by teachers), shaping dexterity (2 factor tests).

Trait variables: persuasibility (5 tests composed of a number of subtests), pupil traits as rated by teachers (30 trait variables).

Situational variables: attitudes (5 attitude tests), sociometric variables (variables measuring leadership and companionship).

Background variables: social status, the number of siblings.

The information obtained was comparatively ample, although there were gaps.

Only the items of information directly associated with the hypotheses, problems and objectives are presented in Part IV. The ground covered by this information was too extensive to be discussed in detail in Part IV.

2. INTRODUCTION

In the behavioural sciences, the term »school achievement» has been understood in a variety of ways, both when it has been used to denote a theoretical concept and when it has been used to name an empirical concept. The study of school achievement has to do, in one way or another, with behavioural changes brought about by learning. Behavioural changes vary in nature. Therefore, an investigator has to specify the field where the behavioural changes he seeks to study take place. In recent times, behavioural research has attempted to circumscribe the objects increasingly precisely, through defining levels, components and relatively invariable general dimensions in the sphere of the functions to be studied. Quantification of school achievement may take place in such a way that school achievement k is quantified at the levels A, B, C, . . . By »levels» are meant general dimensions which can be ordered according to some specified criterion. So far, however, the study of school achievement has not been interested in the definition of such levels. An approach of this kind could, however, open up novel opportunities for the solution of a number of problems, such as those concerned with the changes occurring in thinking during the process of learning. A more usual approach has been to seek to quantify school achievement k, l, m, . . . at the level A. The level A has been defined by applying a variety of criteria; e.g., the aims or the possibilities of quantification have provided a point of departure, or the level has not been specified at all.

The present writer takes an interest in the study of school achievement at various levels. For an empirical study of this kind, a rather extensive theoretical framework and considerable preliminary research would be necessary. Therefore, in the present study the

writer will confine himself to a framework within which school achievement k, l, m, . . . will be quantified at a specified level A. The aim will be to find out what kinds of general, interpret· ble dimensions or factors are spanned by the k, l, m, ...

A problem of both theoretical interest and practical importance is this: In terms of what kinds of functions can school achievement be described or explained? Or, more generally speaking, with what kinds of functions is school achievement associated? An attempt to find out whether an explanation, a description or some other kind of association is involved would necessitate the analysis of highly complicated processes. If the explanation of school achievement by other functions were spoken of, this might lead to misconceptions concerning the causal relationships involved. If the success of an individual in a school subject is associated with his favourable attitudes towards the subject, this could be interpreted in two different ways: favourable attitudes cause success, or success generates favourable attitudes. If only associations or connections were spoken about, the direction of the analysis would not be indicated. Hence, in the following analysis of associations between school achievement and certain other functions, the »description of school achievement in terms of such and such functions» will be spoken of. The objective of this study is to describe school achievement in terms of the functions to be presented in the next section.

The number of observations will be comparatively large in this study. This number is increased by the considerable number of the dimensions employed in quantification. Therefore, an attempt will be made to find techniques of mathematical statistics that render it possible to reduce the number of dimensions, to describe relationships between sets of variables, and to specify fixed and sensed coordinate configurations. In this sense, the study is methodologically oriented.

The principal aims of educational research are to obtain knowledge about educational phenomena, including a knowledge capable of providing a basis for practical recommendations. As the writer sees it, the study of school achievement and the functions in terms of which school achievement can be described is one of the central areas of applied educational research. It belongs, in the writer's opinion, in the basic study in education. The present study is concerned with this area.

3. SOME PREVIOUS STUDIES OF SCHOOL ACHIEVEMENT

A current trend in the behavioural sciences has been to seek to differentiate the area to be investigated. One way to do this is to define behavioural levels and to test these in empirical applications. The level problem was discussed from a theoretical standpoint by, e.g., Underwood (1957). Attempts have also been made to define levels for various behavioural areas, an example of this being provided by the discussion of the levels of verbal behaviour by Himmelstrand (1960). No comparable level analysis has been attempted in the study of school achievement. Such an approach would, however, enable the investigator to

approach school achievement starting from more primary factors than has hitherto been possible.

Also, the study seeking to identify school achievement components is only at an initial stage. By »components» are meant general dimensions representing the same level in a behavioural area, the establishment of which takes place by starting from behaviour mechanisms. The levels again can be ordered according to some specified criterion. The component approach to the study of school achievement is perceptible in Werdelin's (1958, 1959, 1960) and in Pitkänen's (1964) investigations. This approach was followed in the international school achievement study, a part of which was carried out in Finland (Husén 1966; Kuusinen 1967). Two components of mathematical school achievement were defined: a cognitive component and a affective component. The cognitive component was measured by the individual's knowledge of mathematics, while the affective components were measured by attitudes towards mathematics. This establishment of components is associated with the identification of components which has taken place in the sphere of attitudinal behaviour (e.g., Hovland & Janis 1959; Katz 1960).

On the other hand, the study seeking to identify primary factors of school achievement has been pursued to quite a considerable extent. By »primary factors» the writer means comparatively general behavioural dimensions, the establishment of which is based on qualitative aspects of behaviour. Thus, when the study of school achievement behaviour becomes increasingly organized and differentiated, one may state that, at the behavioural level A, the primary factors x, y, z, . . ., consisting of elements a, b, c, . . ., have been extracted from the component X. The research aiming at the identification of primary factors of school achievement has usually represented either of the following two approaches: Starting from the pupil evaluations performed by teachers, and by employing a number of school subjects as the variables, attempts have been made to discover how these school subjects are grouped into primary factors; or, school achievement tests have been employed for the determination of primary factors of success in individual school subjects.

The investigation based on the marks given by teachers has, in fact, provided information on how various school subjects are grouped so as to form primary factors (e.g., Heinonen 1964; Henrysson 1963). The interpretation of primary factors may be done in various ways: one may be content with only analyzing the nature of pupil evaluation or the interpretation may be founded upon various behavioural functions. This kind of study of primary factors is rendered difficult by the problems associated with the creation of variables. Investigations concerned with the area covered by standardized school achievement tests have furnished information on the primary factors identifiable in various individual school subjects (e.g., Vernon 1951; Heinonen 1960, 1961; Karvonen 1963, 1965, 1966; Pitkänen 1965, 1966; Tuomola 1964). Research of this kind represents a higher degree of organization, and the creation of the variables can take place with a higher degree of accuracy than in cases where use is made of the marks given by teachers. Nevertheless, even here the measurement merely pertains to a narrow sector of school achievement behaviour, and the coming into existence of primary factors depends on the number and nature of the variables employed.

4. CHOICE OF THE METHOD OF QUANTIFICATION OF SCHOOL ACHIEVEMENT AND SELECTION OF THE SAMPLE OF PUPILS

The choice of school achievement variables, the way in which these were quantified and the selection of the group of pupils to be investigated were the main determiners of the approach chosen for the empirical part of this study, as well as for a previous study to be reviewed below.

The choice and construction of school achievement variables could be brought onto a more exact basis if it were possible to define different levels and components and perform the measurements accordingly. Such an approach was given up here, because the study of school achievement has not yet mapped out the relevant levels and components. Thus, the framework chosen for this study was such that school achievement k, l, m, . . . was quantified at a level A. Two quantification procedures employed in previous studies were available: those based on school achievement tests and marks given by teachers respectively. The development of school achievement tests is in Finland only at its initial stage, and thus, this possibility was ruled out. Not a single school achievement test suitable for the group of pupils under consideration was available. The standardization of the tests would have postponed the execution of this study for several years. Therefore, marks given by teachers had to be resorted to. The level at which the evaluation of pupils by a teacher takes place is co-determined by the training received by the teacher, the aims of the school and the content of instruction. Certain shortcomings are inherent in the marks given by teachers, considering their use as research variables. These shortcomings are associated with the following: scalability, the technique of evaluation, the specification of the area to be evaluated, the relativity-objectivity balance of evaluation, the variance components, the aims and the constancy of evaluation (Salmela 1948; Lehtovaara & Koskenniemi 1954; Vahervuo 1958; Koort 1959, 1960 and 1964; Gronlund 1965; Odell 1952; in addition, Sipinen's thoroughgoing study on pupil evaluation was published in 1967). Certain measures were undertaken to reduce the shortcomings inherent in marks given by teachers. The differences between different teachers were diminished by restricting the number of teachers to be involved. To this end, the study was made of pupils of the citizenship school (compulsory school years 7 and 8) in which a system approximating the class-teacher system prevails. This made it possible to fix one of the variable factors, i.e., the part played by the teacher. A further fact that spoke for the choice was that the measurements required several school-days, and this excluded the use of secondary grammar school pupils for subjects. To reduce the differences in pupil evaluation between different teachers, the writer also gave training to the teachers concerned, and common tests were arranged with the objective of elucidating the level-difference problem. Certain advantages are also associated with the use of school marks in a study of the present kind. One of the problems to be dealt with was concerned with the associations between school achievement and certain behavioural functions. In cases where school achievement tests are used, certain aspects of school achievement that are involved in the evaluation of pupils' school achievement by their teachers are disregarded. These include the variations in school achievement over time, the scope of school achievement behaviour (some of the aspects attended to by teachers are beyond the scope of school

achievement tests), and the technical possibilities for comparisons between various school subjects.

Thus, the quantification of school achievement was based on school marks and a group of pupils of the Jyväskylä citizenship school (namely, those who began citizenship school in 1961) were used for subjects. Both the choice of the quantification method and that of the sample of subjects were co-determined by the practical measurement possibilities, the writer's familiarity with the school type concerned, the problems of the study and the way in which the variables were to be constructed. The choice of the sample of subjects restricts the generalizability of the results.

The following problem associated with the structure of school achievement was chosen for study:

Problem School Achievement 1. What kinds of primary factors of school achievement emerge when citizenship-school marks are employed as the variables?

5. CHOICE OF VARIABLES DESCRIPTIVE OF SCHOOL ACHIEVEMENT

The ground to be covered by a study of the factors affecting school achievement or associated with it is indeed extensive. The investigation of these factors is, in fact, interdisciplinary in nature: the factors may, besides of educational ones, be also psychological, sociological, physiological, ecological and/or social. For the study to be differentiated enough, the problems should be formulated in such a way as to make it possible to ask: What kinds of associations are ascertainable between school achievement and the factors studied? And this question should be asked concerning different levels, primary factors and different components. Such a formulation of the problem would, however, presuppose a great deal of the development of research in the fields represented by the factors in terms of which the description of school achievement is intended to take place.

The choice of the variables employed in the present study was guided by the results of previous investigations. Nevertheless, an attempt was made at a further analysis of these factors and school achievement. Moreover, it was considered desirable to select groups of variables for which measuring instruments were available and which had been dealt with in previous investigations, so that information was available on the structures of the areas concerned. This was regarded as important, as descriptions in terms of general dimensions or factors was aimed at. Moreover, an effort was also made to include variables which can be influenced; had no such variables been included, it would not have been possible to infer any recommendations from the results.

5. 1. *Intelligence*

Experience and previous studies suggested the use of intelligence variables in the description of school achievement (e.g., Terman 1947; Sjöstrand 1948; Vernon 1951, 1957;

Viitamäki 1956; Kiviluoto 1956, 1959; Heinonen 1964; Marklund et al. 1968). Previous investigations have shown that success in theoretical subjects can be largely described in terms of verbal ability variables, and that the part played by intelligence diminishes with age (e.g., Viitamäki 1956; Kiviluoto 1956, 1959; Bloom 1963; Heinonen 1964). There are also studies to suggest that the associations with intelligence are closer in boys than in girls (e.g., Shinn 1956; Meyer & Bendig 1961; Heinonen 1964). Few studies have been published on the relationships between intelligence factors and success in individual school subjects. Heinonen advanced the hypothesis that, judging by a series of subjects he had studied, success in various school subjects depends on rather specific conditions. Whether this is so is one of the problems to be investigated here. The problems to be considered, the available measuring instruments and the analysis models known to the writer suggested the use of multiple-type factor tests in the quantification of intelligence.

The following hypotheses were formulated on the basis of the previous studies referred to above:

Hypothesis Intelligence 1. Compared with other intelligence variables, verbal ability variables are better able to account for the variance of success in theoretical subjects. This hypothesis can be tested on condition that the reliability of the variables producing associations can be determined.

Hypothesis Intelligence 2. A larger proportion of the variance of school achievement is accounted for by intelligence in the boy group, as compared with the girl group.

In addition, the following problem was set for the study:

Problem Intelligence 3. An attempt should be made to discover which intelligence variables or intelligence factors account for the variance of success in various individual school subjects or the variances of the primary factors of school achievement.

5. 2. *Shaping Dexterity*

The study was concerned with school achievement in a wide sense, and thus, inclusion of motor variables seemed appropriate. The fact that there is a tendency for ability variables to correlate positively and the results of certain previous studies also suggested including such variables (e.g., Heinonen 1960; Pitkänen 1964; Tuomola 1964). The total area of motor functions, though interesting in itself, was not included; the problems of measurement would have been too complicated, and it was considered desirable to restrict the scope of the study. On the other hand, certain dexterity variables were included. Recent studies on the structure of the dexterity domain suggested that, to be able to map out this area, a considerable number of dexterity variables would have been necessary (e.g., Heinonen 1957). Yet, the number of variables was bound to become quite large in any case, and thus the writer chose, on the basis of previous factorial studies, only a few variables measuring shaping dexterity.

Connections between dexterity and practical school subjects have been demonstrated in previous studies (e.g., Oinonen 1960; Tuomola 1964). Dexterity variables have been included only in studies dealing with certain narrow areas of school achievement, and therefore, merely the following problem was specified here:

Problem Dexterity 1. What are the school subjects and primary factors of school subjects whose variance can be accounted for to an appreciable extent in terms of shaping dexterity?

5. 3. *Persuasibility*

It seemed probable, both on logical grounds and on the basis of experience and previous studies (e.g., Viitamäki 1956), that a part of the variance of school achievement could be accounted for in terms of certain personality variables. The search for relationships between personality traits and school achievement is a comprehensive task, and the study of such relationships would be of utmost importance. In individual studies, only narrow sectors of this area can be mapped out. Only the personality trait area termed persuasibility was included in this study. The choice was partly due to the fact that persuasibility and its connections with other functions have been studied quite extensively. When the present study was started, however, interrelations between persuasibility and school achievement had not yet been investigated. The choice was also motivated by certain practical considerations: the writer had constructed measuring instruments for the quantification of persuasibility, and these were suitable for use in this study.

The investigation of persuasibility is largely the merit of the Yale team (Hovland 1957; Hovland & Janis (eds.) 1959; Hovland & Rosenberg (eds.) 1960; Hovland, Janis & Kelly 1961). The theoretical foundations of the study of persuasibility have to do with Festinger's (1957) dissonance theory, Heider's (1946) balance theory and Osgood's (1957) congruity concepts. What is involved in persuasibility is the process of the acceptance of information. The Yale team, and Rosenberg in particular, have put forward views concerning the balance between stimulus and individual, and concerning the mechanism affecting this balance. The theoretical basis of persuasibility has been discussed by the present writer in a previous article (Niskanen 1964). The Yale team has distinguished between two sorts of persuasibility: specific persuasibility and general persuasibility.

Specific persuasibility (communication bound factor) is fo be found in cases where an attempt is made to keep the factors involved in the persuasion process, such as the situation, content and communicator, separate from one another. General persuasibility (communication free factor) is found in cases where the effects of the various factors are not analyzed separately, but only the individual's general acceptance is investigated.

In the studies of persuasibility carried out by the present writer, two types of primary factors of general persuasibility have emerged: attitude-dependent and attitude-independent. The writer has interpreted these to indicate differences in the motivational basis; Katz's (1960) analysis of the applicability of the persuasibility factor lent support to this. In the present study, the measuring instruments constructed by the writer for attitude-dependent and attitude-independent persuasibility were employed in the quantification of the persuasibility variables included in it.

There are facts suggesting the existence of interrelations between persuasibility and school achievement. Considered as processes, these phenomena involve partly identical functions; both can be described in terms of the same mechanisms; the mediating processes are the same in part; and a change as well as balance is involved in both. Moreover, interrelations of intelligence and persuasibility have been demonstrated in a few previous studies (e.g., Janis & Field 1959; Niskanen 1964). As the present study is the first to investigate interrelations between persuasibility variables and school achievement in an empirical setting, the writer found it preferable not to advance any specific hypotheses to be tested, especially because various

persuasibility factors have behaved differently when their relationships with intelligence have been studied; attitude-dependent persuasibility has been associated with verbal factors more clearly than attitude-independent persuasibility. Therefore, merely the following problem was set for the study:

Problem Persuasibility 1. An attempt should be made to identify the school subjects or the school subject primary factors the variances of which can be accounted for to an appreciable extent by attitude-dependent and/or attitude-independent persuasibility.

5. 4. *Pupils' Traits as Rated by Teachers*

Since persuasibility variables were the only personality trait variables proper in the present study, certain additional trait variables were included. These were obtained from the ratings made by the teacher of vocational guidance of certain traits of the pupils. These variables were expected to account for a proportion of the variance of some school achievement variables, and to elucidate certain problems associated with pupil evaluation. The manner in which these variables were constructed was problematic, from a statistical point of view; therefore, answers were not sought to any well-defined questions concerning these variables. These variables were intended to serve the following objectives:

Objective Trait 1. An attempt should be made to discover what types of pupil traits, as rated by teachers, might be capable of accounting for the variance of school achievement to an appreciable extent. The information obtained on this point should be used for framing hypotheses for continuation studies.

Objective Trait 2. The rating variables should be utilized to elucidate the pupil evaluation process.

5. 5. *Situational Factors*

Situational factors were given a pivotal place among the variables in terms of which an attempt was to be made to account for the variance of school achievement. A situational factor may relate to the way in which the individual experiences the situation. What is involved are the individual's attitudes towards the situation. On the other hand, the way in which an individual is experienced in the situation may be in question. This aspect will be approached through sociometry.

5. 5. 1. *Attitudes*

A search for interrelations between attitudes and school achievement was suggested by studies which had demonstrated the existence of connections between positive attitudes and the acceptance of information (e.g., Festinger & Kelly 1951; Smith, Bruner & White 1956; Hovland & Janis 1959; Hovland, Janis & Kelly 1961; Werdelin 1960, 1966; Niskanen 1964). Also, certain studies on interrelations between attitudes towards various school subjects and school achievement were of assistance in the choice of attitude variables, even though these studies suggest that the interrelations are complicated (e.g., Biggs 1959; Aiken & Dreger 1961; Evans 1965).

The number of school achievement variables was large in the present study, and therefore it was considered advisable not to analyze the interrelations between attitudes towards individual school subjects and success in these subjects. Instead, the study was confined to the relationship between the one that is the sender of information in a learning situation and school achievement.

The teachers and the peers can be regarded as the most important communicators in learning situations. If the learning situation

is considered in an extensive sense, parents can also be counted among the communicators. Therefore, teachers, peers and parents were chosen as the objects of the attitudes to be considered. Likert-type attitude measuring instruments constructed by the writer were employed in the quantification of attitudes. The current trend in the field of attitude measurement, which attempts to distinguish various components in attitudes, did not find empirical application in the present study: the term »attitude» was used simply to indicate the positive or negative way of relating to certain objects.

The following hypothesis was formulated concerning the interdependence of attitudinal and school achievement variables:

Hypothesis Attitude 1. A positive attitude towards the communicator is likely to be associated with good school achievement.

Furthermore, the following problem as regards the attitudinal variables was specified:

Problem Attitude 2. An attempt should be made to discover which of the attitudinal variables are capable of accounting for the variance of school achievement variables.

5. 5. 2. *Sociometric Variables*

Not only the way in which the pupil experiences the learning situation but also the way in which he is experienced by his peers was taken into consideration here, and, to this end, sociometric variables were included. The choice of sociometric variables was co-determined by the existing possibilities of measurement and by previous studies, which have demonstrated the existence of certain general sociometric dimensions (e.g., Moreno 1934; Koskenniemi 1936, 1943, 1952; Bjerstedt 1956, 1963). Two main dimensions, leadership and companionship, were chosen for the present study.

If Bjerstedt's efficiency concept is taken as the starting point, school achievement variables and sociometric variables could be expected to be interrelated. Bjerstedt (1956) defines work efficiency and interaction efficiency. It would be reasonable to assume that a learning situation might provide an opportunity to investigate interrelations between work efficiency and interaction efficiency, particularly in view of the fact that studies concerning leadership and efficiency have been published where the behaviour of groups representing the extreme ends of these two dimensions has been investigated (e.g., Homans 1950; Allardt et al. 1958). Cues for a search for interrelations are also furnished by theoretical and empirical studies on the school-class atmosphere (e.g., Koskenniemi 1952; Husén et al. 1959). Also, previous studies on sociometric variables and certain school achievement variables have demonstrated the existence of interrelations (e.g., Takala et al. 1964; Pitkänen & Takala 1962).

The following hypotheses on the interrelations between school achievement and sociometric variables were formulated:

Hypothesis Sociometric 1. Leadership is capable of accounting for a proportion of the variance of school achievement.

Hypothesis Sociometric 2. Companionship is capable of accounting for a proportion of the variance of school achievement.

Moreover, the following problem was specified:

Problem Sociometric 3. An attempt should be made to discover the individual school subjects and the school subject primary factors the variances of which can be accounted for by the leadership or companionship variables or by the primary factors of sociometric variables.

5. 6. *Social Status and the Number of Siblings*

It would be of some interest to investigate how far various variables descriptive of the pupil's home conditions are capable of accounting for the variance of school achievement. Only two such variables, however, were included in the present study.

Previous studies (e.g., Sims 1951; Brandt 1955; Husén 1948; Husén et al. 1959; Heinonen 1964) suggested the inclusion of social status. The following problem associated with the relationship between social status and school achievement was specified:

Problem Status 1. Which are the school subjects the variance of which can be accounted for to an appreciable extent by social status?

Heinonen's (1968), Nisbet's (1953) and Pamberton's (1963) studies on the influence of the structure of the family upon the mental development of the child made it appear useful also to include the number of siblings as a variable in the present study. The following problem associated with this variable was formulated:

Problem Sibling 1. Which are the school subjects the variance of which can be accounted for to an appreciable extent by the number of siblings?

6. THE HYPOTHESES, PROBLEMS AND OBJECTIVES OF THE PRESENT STUDY

The hypotheses, problems and objectives of the present study are, consequently, the following:

Problem School Achievement 1. What kinds of primary factors of school achievement emerge when citizenship-school marks are employed as the variables?

Hypothesis Intelligence 1. Compared with other intelligence variables, verbal ability variables are better able to account for the variance of success in theoretical subjects. This hypothesis can be tested on condition that the reliability of the variables producing associations can be determined.

Hypothesis Intelligence 2. A larger proportion of the variance of school achievement is accounted for by intelligence in the boy group, as compared with the girl group.

Problem Intelligence 3. An attempt should be made to discover which intelligence variables or intelligence factors account for the variance of success in various individual school subjects or the variances of the primary factors of school achievement.

Problem Dexterity 1. What are the school subjects and primary factors of school subjects whose variance can be accounted for to an appreciable extent in terms of shaping dexterity?

Problem Persuasibility 1. An attempt should be made to identify the school subjects or the school subject primary factors the variances of which can be accounted for to an appreciable extent by attitude-dependent and/or attitude-independent persuasibility.

Objective Trait 1. An attempt should be made to discover what types of pupil traits, as rated by teachers, might be capable of account-

ing for the variance of school achievement to an appreciable extent. The information obtained on this point should be used for framing hypotheses for continuation studies.

Objective Trait 2. The rating variables should be utilized to elucidate the pupil evaluation process.

Hypothesis Attitude 1. A positive attitude towards the communicator is likely to be associated with good school achievement.

Problem Attitude 2. An attempt should be made to discover which of the attitudinal variables are capable of accounting for the variance of school achievement variables.

Hypothesis Sociometric 1. Leadership is capable of accounting for a proportion of the variance of school achievement.

Hypothesis Sociometric 2. Companionship is capable of accounting for a proportion of the variance of school achievement.

Problem Sociometric 3. An attempt should be made to discover the individual school subjects and the school subject primary factors the variance of which can be accounted for by the leadership or companionship variables or by the primary factors of sociometric variables.

Problem Status 1. Which are the school subjects the variance of which can be accounted for to an appreciable extent by social status?

Problem Sibling 1. Which are the school subjects the variance of which can be accounted for to an appreciable extent by the number of siblings?

The computational and other comparable operations will take place at two levels: the variable level and the factor level. The approach followed in the study is such that an attempt is made to describe school achievement in terms of the other variables chosen for the study; or, in other words, the other variables will be made to account for the variance of school achievement. This approach can be illustrated, in terms of matrices, by the following schematic representation. This matrix scheme also provides an opportunity for an analysis in terms of the matrix elements or vectors.

$$\left[\begin{array}{l}(\text{intelligence}) \\ (\text{shaping dexterity}) \\ (\text{persuasibility}) \\ (\text{pupils' traits as rated by teachers}) \\ (\text{attitudes}) \\ (\text{sociometric variables}) \\ (\text{social status}) \\ (\text{number of siblings})\end{array}\right] \dashrightarrow (\text{school marks})$$

Part IV: Results and Discussion

PART IV
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1. INTRODUCTION

Part I of the writer's studies on school achievement has the following three problem areas: (1) investigation of the structure of school achievement, (2) description of school achievement in terms of selected personality variables, and (3) application of multidimensional statistical operations in situations where it is considered desirable to reduce the number of dimensions and to describe a set of dependent variables in terms of a set of independent variables in a single operation. The operations carried out are presented in Parts II and III of this study, which also include a detailed account of the information yielded by the operations. Nevertheless, space does not permit the presentation of all relevant comments, interpretations or generalizations. Therefore, as the writer has pointed out in a number of previous contexts, certain methodological and factual problems of some interest will later be dealt with elsewhere. In the present Part IV the results will be discussed only from the standpoint of the hypotheses, problems and objectives formulated in advance.

2. INVESTIGATION OF THE STRUCTURE OF SCHOOL ACHIEVEMENT

In Part I of this study the framework for the investigation of school achievement was specified in such a way that an attempt should be made to quantify school achievement, k, l, m, . . ., at a given level A. The following problem School Achievement 1 was formulated: What kinds of primary factors of school achievement will emerge when marks in the citizenship school reports are employed as the variables? Information relevant to this problem was yielded by the factor analytical operations carried out.

The information obtained through the principal components analysis is presented in Tables 4 to 6 of Part II. Only the most important of the principal components are interpreted, and the school subjects which remain outside these first components are ndicated.

The components obtained for the girl group are the following:

I. a general component of theoretical subjects
II. a (general) component of skill subjects (or practical subjects)

The largest part of the variance of music, home economics and penmanship remains outside these components.

The components for the boy group are the following:

I. a general component of school subjects
II. a (partial) skill subjects component
III. a handicrafts component
IV. a home economics component
V. an oral presentation component

The components for the combined group are as follows:

I. a general component of school subjects
II. a skill subjects component

The largest part of the variance of home economics, handicrafts, physical education and drawing remains outside these components.

The information yielded by the principal components analyses is utilized in the determination of the number of factors to be extracted by the principal factor method and in the interpretation of the factors yielded by the varimax rotation. Information on these points is included in Tables 7 to 12 of Part II.

Both a four-factor and a five-factor rotation was carried out for each group. The interpretations are based on the five-factor rotations.

The factors for the girl group are interpreted by the writer as follows:

I. a home economics factor (which might also be regarded as a factor of careful activity)
II. a partial factor of skill subjects (not including music)
III. a theoretical subjects factor
IV. a specific citizenship school theoretical subjects factor
V. a mathematical factor

The factors for the boy group are interpreted as follows:

I. a (general) theoretical subjects factor
II. a partial skill subjects factor (not covering woodwork or metalwork)
III. a handicrafts factor
IV. a home economics factor
V. a reading factor

The factors for the combined group are interpreted as follows:

I. a general theoretical subjects factor
II. a (partial) skill subjects factor (not covering handicrafts)
III. a home economics factor
IV. a book-keeping factor
V. a handicrafts factor

The school subjects are also included in the factor analyses made of all the school achievement variables and the variables chosen to account for the variance of school achievement. The information concerning these analyses is included in Tables 35 to 37 of Part II.

In these analyses the main objective was not structural investigation; instead, an effort was made to identify relationships with school achievement variables of a set consisting of a large number of variables by employing a small number of dimensions. Thus, the interpretations concerning the structure of school achievement were only intended to reveal the most clear-cut dimensions. A theoretical subjects factor emerged for each group. In addition, a skill subjects factor was obtained for the boy group and the combined group; for the girl group, no independent skill subjects factor was obtained, but, when use was made of a small number of dimensions in the rotation, a composite skill subjects and dexterity factor emerged. In this analysis, the invariance of the factors for boys and girls was investigated through congruence coefficients and symmetric transformation analysis. The congruence coefficients and the transformation matrix (Part II, Table 42 and Tables 53 to 58 respectively) suggest the following conclusions: the correspondence between the theoretical subjects factors is very close (the coefficients exceed .80) and that between the skill subjects factors is close (the coefficients exceed .50). The skill subjects factor for girls also involves dexterity, and thus it is associated with both the skill subjects and dexterity factors for boys. The congruence coefficients also enabled a comparison of the factors for girls and those for boys with the factors for the combined group. The results for the combined group were discovered to be compatible with those obtained for the girl and boy groups.

Transformation analysis also yielded more detailed information concerning the invariance of the factor structures of the girl and boy groups. The factor-specific residuals, or the matrices Diag E (2, 3)'E (2, 3) and Diag E (3, 2)' E (3, 2) in Part II, indicate that those of the theoretical subjects factor are the largest irrespective of the direction of transformation. The residuals of the skill subjects factor are near the average value. The variable-specific residuals can be employed to identify the school achievement variables that caused the invariance. These residuals are presented in the form of two components: the differences in length and the angular separations; matrix Diag E (2,3) E (2,3)'. The largest differences in length are those revealed by music, reading (and literature) and home economics. The largest angular separations are encountered in home economics and music.

A more fruitful approach to the comparative structural analysis of school achievement might have been to employ a pure school achievement battery. Such an analysis was not, however, undertaken in the present study.

At least a theoretical subjects factor and a skill subjects factor were yielded by each of the operations employed in this study to investigate the structure of school achievement. This result is in line with the findings of Heinonen (1964) and Henrysson (1963). Concurrently with the study reported here, the writer has conducted investigations concerning the structure of school achievement with secondary grammar school pupils (Niskanen, unpublished). These investigations cover the 2nd, 5th, 7th and 8th secondary grammar school years, and they suggest the existence of a factor which might be termed a theoretical subjects factor. Moreover, they reveal a tendency for skill subjects to form a factor of their own.

The more detailed analysis of citizenship school achievement, as carried out in the present study, resulted in five factors. The emergence of a theoretical subjects factor can be interpreted to reflect the process of pupil evaluation: it is impossible for the teacher to attend to the specificity of each school subject in evaluating a pupil. These sources of error associated with pupil evaluation are discussed in Parts I and II. On the other hand, the emergence of an extensive theoretical subjects factor can be due partly to the mathematical and statistical procedures employed: the multidimensional techniques employed are apt to span general dimensions. This is particularly characteristic of the varimax method of rotation. Nevertheless, the fact that a theoretical subjects factor was obtained can be interpreted to reflect the existence of certain more primary functions of behaviour: the types of school achievement concerned rest on certain underlying common functions.

The emergence of skill subjects factors may also be interpreted as being due to certain characteristics of pupil evaluation. A pupil's achievement in skill subjects is evaluated in a manner definitely different from the way in which his achievements in theoretical subjects are evaluated. This difference may be due to a variety of factors. These are discussed in Parts I and II. The writer is inclined to assume, however, that the emergence of skill subjects factors reflects the existence of primary functions that determine a pupil's success in skill subjects, which are regarded as secondary in importance.

A home economics factor was obtained for each pupil group, and its emergence could be interpreted to reflect the process of pupil evaluation. The training of home economics teachers differs from that of other

citizenship school teachers. Thus, the principles they follow in pupil evaluation may also differ from those followed by other teachers. An alternative possibility is the following: when the achievement of a pupil in home economics and related school subjects is evaluated, attention is given not only to his knowledge and skill but also to his working habits and practices. A fact speaking for this alternative was that the home economics factor for the girl group covered an area wider than that of home economics alone, which the writer termed »careful activity». Also, the functions in terms of which this factor and the variables spanning it were describable suggest that what was involved was a school work factor of a more general kind. The present data did not, however, furnish direct evidence in support of this view. Nevertheless, the identification of such working factors could be aimed at in future studies on the structure of school achievement.

The fact that a clear-cut handicrafts factor emerged for the boy group has a natural explanation: there were two handicrafts variables for boys, viz., woodwork and metalwork, but only one variable for girls. Thus, a problem pivotal to the interpretation of school achievement dimensions is encountered: the emergence of various dimensions depends decisively on the battery employed. Therefore, all the interpretations put forward should invariably be understood to mean this: the battery employed resulted in the emergence of such and such dimensions for the group of pupils studied. It is up to future studies to determine to what extent the dimensions are invariant. The associations of handicrafts with other variables, which will be considered in detail below, indicate, however, that the handicrafts factors that were obtained rest upon specific underlying functions; in consequence, handicrafts, as a school subject, are specific in nature.

A factor interpreted as a specific mathematical factor was obtained for the girl group. In the boy group, the variance of mathematics was accounted for by the general theoretical subjects factor. The writer is inclined to interpret this difference between girls and boys as follows. Inspection of the associations which the various operations revealed between boys' success in theoretical subjects and a number of other variables justify the simplified generalization that their achievement in theoretical subjects is of the reasoning-type, or the manner in which their achievement is evaluated emphasizes the reasoning component. Therefore, mathematics, which is loaded on reasoning, falls within the general theoretical subjects factor in the case of boys. On the other hand, girls' achievement in theoretical subjects is of a verbal type; and, in consequence, the general theoretical subjects factor for girls is unable to account for the entire variance of mathematics, which is a reasoning-type school subject.

The emergence of a reading (and literature) factor for boys lends additional support to this view. The general theoretical subjects factor for boys is predominantly a reasoning-type factor, and thus it is incapable of explaining success in reading (and literature) or in composition, which are verbal-type activities; the first is loaded in part on the skill subjects factor, whereas the second forms a separate factor, in conjunction with civics, religion and composition. Thus, the specificity of verbal ability manifests itself in the emergence of what was termed a reading factor.

The above interpretation of the school subjects factors was intended to be of a comparatively general nature. This interpretation becomes increasingly detailed in subsequent chapters, which are concerned with the description of school achievement.

3. A CRITICAL APPRAISAL OF THE STRUCTURAL STUDY OF SCHOOL ACHIEVEMENT

When an attempt is made to appraise a study concerning the structure of school achievement, attention should be given to the following: the properties of the variables, the battery employed, the methods and the sample of pupils. The problems associated with the construction of school achievement variables are discussed in Parts I and II. These problems will not be discussed by the present writer at greater length, particularly because three extensive studies on the problems of pupil evaluation have been carried out over the years during which this study was in progress (Koskenniemi et al. 1965; Alikoski 1963; Sipinen 1967).

The possible differences in pupil evaluation between various teachers constitute a factor which complicates the interpretation of the dimensions obtained: the part played by pupil evaluation in the emergence of school achievement dimensions is difficult to ascertain. Considerable difficulties are also encountered when an effort is made to render the school marks comparable; this was the case in the present study, too, even though an attempt was made to reduce the importance of the teacher as a variable factor and certain measures, described in Part I, were undertaken to this end in advance. The complications due to differences between teachers in pupil evaluation could have been avoided by confining the study to a single class only. The procedure chosen for this study was such, however, that the variables were created over school classes. An alternative possibility would have been to compute the necessary correlations for each class separately and then to combine the correlation coefficients. The mathematical foundations of such operations have not, however, been dealt with in the behavioural sciences, even though certain recent applications can be referred to (e.g., Alikoski, a manuscript).

The solving of the reliability of school achievement variables is difficult. In an experimental study it would be possible to cope with this problem by varying the teacher systematically. In a school class situation this possibility did not exist, and thus it was impossible to determine the rater reliability. In factor analytical studies of a certain kind, the communalities can be employed to measure the lower limits of the reliabilities. The communalities of a school achievement battery cannot, however, be used as the estimates of the reliabilities. This is because these communalities involve two component areas. One component can be regarded as being due to the interrelations between the performances proper, while the other component is liable to reflect factors associated with evaluation, such as the halo-effect. The contributions of these two components to the communalities are difficult to estimate. The low communalities of certain school subjects may be due to the fact that, as a result of the nature of the battery, the common variance of these subjects is small. The reliability problem remains open in this study.

On the other hand, the operations carried out would enable one to attack the problem of validity, though only in part. The interrelations that have been found to hold between the school achievement variables and the variables used to account for the variance of these variables might be considered from the standpoint of construct validity. Regarding the interrelation between school achievement and intelligence, for example, it would be possible to ask: Do the numerical ability

variables bear higher correlations to school marks in mathematics than to the other school achievement variables? The present data suggest an affirmative answer to this question. To be able to give an answer to the question, however, it would be necessary for us to know the reliabilities of all the variables involved in the correlations; to determine how large, at most, the correlation coefficients could be when the reliabilities are taken into account; and, finally, to find out how close to these maximum values the empirical correlations are. Thus, our conclusions should be based on difference variables. When the fact is also taken into consideration that the reliability coefficients yielded by different methods are different and that the reliabilities are affected by the observational data, we are faced with a highly complicated situation. This is obviously why the problems of reliability and validity are rarely subjected to a thoroughgoing empirical analysis in studies related to the behavioural sciences. The situation in the present study could be simplified by introducing certain presuppositions. The approach in that part of the present study which was concerned with the discovery of interrelations was not, however, methodological in character. Therefore, no separate investigation of construct validity will be undertaken here: such investigation would, in fact, overlap the consideration of the results included in the following chapters.

When results concerning the structure of school achievement are appraised, attention must also be given to the battery employed. Only those citizenship school subjects were included in the present battery that were being taught to all individuals in the sample of pupils. It should be kept in mind, therefore, that a different kind of configuration might have resulted had additional subjects been included in the battery. As a matter of fact, one of the tasks awaiting fundamental research concerning the structure of the performances in various school subjects is the attempt to discover invariant school achievement factors.

The structures that emerged have also been co-determined by the factor analytical methods employed. That multiple-type factoring methods were chosen for the present study was due to two different facts. First, similar methods had been used in the construction of some of the measuring instruments. Secondly, these methods had also been employed in certain previous school achievement studies, and their use in the present study facilitated comparisons. Had group-type methods been used, the resulting configurations would have been different.

The sample of pupils also had a bearing on the structures discovered. The pupil groups were so small that the structures may display random variations. All the pupils in the sample came from a single town, and this was liable to make for configurational variability. Hence, in order to discover how invariant the structure is, comparable studies with other pupil groups should be carried out.

When an attempt is made to appraise the information available on school achievement, it must be admitted that the methods for the determination of its dependability leave considerable room for improvement. An epistemologist would probably say that it is unnecessary to delve into these matters. Sharing the opinion put forward by Eskola (1967) that it pays to investigate important questions even where one has to risk inexactitude, the writer proceeds to consider the second group of factual problems covered by this study: the description of school achievement in terms of the variables chosen for the purpose.

4. DESCRIPTION OF SCHOOL ACHIEVEMENT IN TERMS OF VARIABLES USED IN THE STUDY

4. 1. *Intelligence*

4. 1. 1. *Results*

The data available for this purpose were quite comprehensive. This area alone is of considerable interest in itself. In this part of the study, however, the writer merely considered two hypotheses, (I1 and I2) and one rather narrowly circumscribed problem (I3). The intercorrelations of the variables in terms of which school achievement was intended to be described complicated the analysis of the results at the variable level. In setting out to consider the hypotheses, the complicated problem of hypothesis testing is encountered. This problem necessitates a theoretical analysis, which will be undertaken at the end of this part, where the problem of the explanation of behaviour is discussed. The research design was such that it did not permit testing the hypotheses step by step; therefore, an attempt will be made to discover only whether the available information included items which can be considered to confirm the hypotheses. Owing to the abundance of information, the results concerning the research problems will be presented only in general terms.

Hypothesis Intelligence 1 was formulated as follows: Compared with other intelligence variables, verbal variables are better able to account for the variance of success in theoretical subjects. When this hypothesis was advanced, the writer pointed out that it can be tested only on the condition that the reliabilities can be determined. The above discussion of school achievement variables revealed, however, that the reliabilities of these variables cannot be determined. On the other hand, inspection of the reliability coefficients of the intelligence variables, which were presented previously, reveals that the coefficients for the verbal variables did not differ appreciably from those of the other intelligence variables. The writer supposes, therefore, that Hypothesis I 1 can be subjected to investigation.

In the Introduction, matrices were employed to describe school achievement. The elements of the matrices and vectors can be employed in testing the hypothesis. The operations that were carried out yielded information on variable-level and factor-level correlation matrices, on factor analyses and on canonical analyses.

Inspection of the variable-level correlation matrices (Part II, Tables 26 to 28) suggests that certain correlations, and some correlations for the girl group in particular, could be taken to reinforce the hypothesis. However, the number of correlation coefficients was so large (1,305 correlation coefficients were computed) that they cannot be considered in detail.

Inspection of the factor matrices for the school achievement and intelligence variables (Part II, Tables 29 to 34) reveals that, in the case of the girl group, 26 per cent of the variance of reading (and literature) and 9 per cent of that of composition is accounted for by the verbal factor. The verbal factor for the boy group accounts for 18 per cent of the variance of composition and for 10 per cent of that of reading (and literature). Finally, the verbal factor obtained for the combined group accounts for 18 per cent of the variance of reading (and literature) and for 22 per cent of that of composition. The shortcomings of the analytical model employed are discussed in Part II. The results presented above confirm the hypothesis, although to a limited

extent only.

The results yielded by the variable-level canonical analysis cannot readily be employed to assess the tenability of Hypothesis I 1. Moreover, since the revised canonical program (Canon/Nummi) could not be applied in the present study — owing to the fact that the capacity of the computer of the Computer Centre of the University of Helsinki was not sufficient for the present battery — the hypothesis will not be considered in the light of canonical analysis.

The factor score correlation matrices yielded by the factor-level operations (Part III, Tables 74, 77 and 80) contain information relevant to Hypothesis I1. The results show that, in the girl group, the correlations that the verbal factor and the verbal comprehension factor bear to the general theoretical subjects factor are higher than the correlations that the other intelligence factors bear to this school achievement factor. The differences between the correlation coefficients will not be tested for statistical significance, and thus the finding can only be used for purposes of orientation. An analysis of the differences between the correlation coefficients would presuppose an estimation of the reliabilities of the factor scores. The reliabilities of the factor scores have not, however, been estimated in this study. The associations that were found to exist between the citizenship school theoretical subjects factor and the intelligence factors do not reinforce the hypothesis. In the boy group, the associations between the theoretical subjects factor and the intelligence factors also do not reinforce the hypothesis: the correlational associations of the reasoning factors with the theoretical subjects factors are closer than those of the verbal factors. By contrast, the home economics factor and the reading (and literature) factor are related to the verbal factors more closely than to the other intelligence factors. As regards the combined group, the associations between the general theoretical subjects factor and intelligence factors do not reinforce the hypothesis. The correlation that the home economics factor bears to the verbal factor is higher than the correlations it bears to the other intelligence factors.

By employing factor scores as the variables, factor analyses were carried out that furnished information on how the variables were grouped into factors. These analyses permit the following conclusions concerning Hypothesis I 1 (Part III, Tables 76, 79 and 82): In the girl group, the theoretical subjects factor is associated with the verbal factor. In the boy group, the home economics factor is associated with the verbal comprehension factor and the reading (and literature) factor is associated with the verbal fluency factor. None of the results obtained for the combined group lend support to the hypothesis.

The canonical analyses made from the factor scores do not yield information relevant to Hypothesis I 1.

The above detailed consideration of Hypothesis I 1 suggests that it was not formulated in specific enough terms: further specifications would have been necessary in order to make it possible to test the hypothesis against empirical data. In the case of the girl group, the area of theoretical subjects is split into a verbal-type general theoretical subjects factor and reasoning-type specific factors. It was seen that, in the girl group, the verbal intelligence variables account for a larger proportion of the variance of the general theoretical subjects factor obtained for this group than do the other intelligence variables; the writer supposes that these findings can be considered to confirm Hypothesis I 1. As for the boy group, the reasoning factors, rather than the verbal factors, account for the variance of

the general theoretical subjects factor. In this group, the hypothesis found support only in certain component areas of success in theoretical school subjects: those represented by the reading (and literature) factor and the home economics factor.

Hypothesis Intelligence 2 was formulated as follows: A larger proportion of the variance of school achievement is accounted for by intelligence in the boy group, as compared with the girl group. Some of the operations intended for the testing of this hypothesis were given up by the writer, since the operations that were carried out seemed to suggest that the hypothesis was formulated in an excessively global manner. One operation of this kind would have been a canonical analysis covering school achievement and intelligence alone. Thus, the information available for testing the hypothesis is scanty. The hypothesis will not be considered in the light of the correlation coefficients; these coefficients were too numerous to be discussed here. The problem could be attacked by employing factor-level and variable-level correlations to compute common indices, or by analyzing and comparing the common-factor variances in factor analysis. The above discussion of the results of the structural analysis of the success in various school subjects, as well as the discussion of Hypothesis I 1, suggested the following: when girls and boys are compared with respect to the variables that are best able to account for the variance of their school achievement, it is appropriate to advance hypotheses concerning the ability of various special components of intelligence to account for the variance of special components of school achievement, rather than to introduce hypotheses concerning the differences in the total variance of school achievement, considered as a whole. Some light on these problems will be shed by the following discussion of problem I 3: An attempt will be made to identify the intelligence factors whose ability to account for the variance of school achievement is different in the case of girls and in the case of boys.

Problem Intelligence 3 was formulated as follows: An attempt should be made to discover which intelligence variables or intelligence factors account for the variance of success in individual school subjects or the variance of the primary factors of school achievement. There are several significant correlations between school achievement variables and intelligence variables (Part II, Tables 26, 27 and 28). To facilitate the interpretation of these correlation coefficients, factor analytical operations were carried out.

The variable-level factor analyses (Part II, Tables 30, 32 and 34) reveal that, in each pupil group, the numerical ability factor accounts for an appreciable proportion of the variance of mathematics, while the verbal ability factor accounts for an appreciable proportion of the variance of reading (and literature) and composition. Moreover, in the case of the boy group, the visualization and numerical reasoning factor is capable of accounting for the variances of theoretical subjects and skill subjects to an appreciable extent.

The variable-level canonical analyses (Part II, Tables 59 to 61) furnish information on interrelations between intelligence and school achievement variables. Several of the descriptive axes are constituted by intelligence variables. The interdependences within the various sets of variables and the nature of the analytical model employed had the consequence that the interpretation of the axes was rendered ambiguous. Therefore, no detailed interpretation of the pairs of axes will be attempted here.

The factor-score correlation matrices (Part III, Tables 74, 77 and 80) also contain infor-

mation on interrelations between school achievement and intelligence. The following correlations between school achievement factors and intelligence factors are significant at least at the .05 level:

The Girl Group

home economics factor — intelligence as rated by teachers

partial factor of skill subjects — verbal comprehension factor, numerical factor, intelligence as rated by teachers

theoretical subjects factor — verbal factor, intelligence as rated by teachers, verbal comprehension factor, numerical factor, visualization and reasoning factor

citizenship-school theoretical subjects factor — visualization and reasoning factor

mathematical school achievement factor — numerical factor, visualization and reasoning factor, verbal comprehension factor and numerical factor

The Boy Group

theoretical subjects factor — non-verbal reasoning factor, verbal comprehension factor, numerical factor

partial skill subjects factor — verbal comprehension factor, non-verbal reasoning factor

handicrafts factor — non-verbal reasoning factor, visualization and numerical reasoning factor

home economics factor — verbal comprehension factor, verbal and non-verbal reasoning factor, numerical factor, verbal fluency factor

reading (and literature) factor — verbal fluency factor

The Combined Group

general theoretical subjects factor — non-verbal reasoning factor, numerical special factor, verbal factor, numerical factor

skill subjects factor — verbal factor, perceptual speed factor

home economics factor — verbal factor

book-keeping factor — numerical factor

handicrafts factor — non-verbal reasoning factor

The factor analyses based on factor scores (Part III, Tables 76, 79 and 82) reveal the following kinds of interrelations (a more detailed consideration of these interrelations was undertaken in Part III):

The Girl Group

The mathematical school achievement factor is related to the visualization and reasoning factor and the numerical factor.

The theoretical subjects factor is related to the verbal factor and the factor of intelligence as rated by teachers.

The skill subjects partial factor is related to the verbal comprehension and numerical factors.

The home economics factor is related to the factor of intelligence as rated by teachers.

The Boy Group

The theoretical subjects factor is related to the non-verbal reasoning factor.

The handicrafts factor is related to the visualization and numerical reasoning factor.

The home economics factor is related to the verbal comprehension factor and the non-verbal and verbal reasoning factor.

The reading (and literature) factor is related to the verbal comprehension factor.

The Combined Group

The theoretical subjects general factor is related to the perceptual speed factor.

The home economics factor is related to the visualization and reasoning factor.

The book-keeping factor is related to the numerical factor.

The handicrafts factor is related to the numerical special factor.

The factor-level canonical analyses (Part III, Tables 86, 87 and 88) reveal the following: Only a single significant pair of axes emerges for the girl group; this pair of axes describes the theoretical subjects factor, the mathematical school achievement factor and the skill subjects partial factor in terms of the factor of intelligence as rated by teachers and the numerical factor.

Three significant axis pairs emerge for the boy group, and the part played by intelligence is as follows (a more detailed account is included in Part III): In the first pair of axes, the skill subjects partial factor and home economics factor are described in terms of the verbal comprehension factor and the visualization and numerical reasoning factor. In the second axis pair, the theoretical subjects factor and the reading (and literature) factor are described in terms of the non-verbal reasoning factor, numerical factor and the verbal fluency factor. For the combined group, three pairs of axes for which the canonical correlation reached a statistically significant level are obtained. In the first pair, the theoretical subjects factor, and the skill subjects, home economics and handicrafts factors combined with it, are described in terms of the verbal factor, non-verbal reasoning factor and perceptual speed factor. In the second pair, the book-keeping factor, the theoretical subjects factor and handicrafts factor are described in terms of the numerical special factor and the verbal factor. In the third pair, all the school achievement factors are described in terms of all the intelligence factors.

4. 1. 2. *Discussion*

When the results obtained in describing school achievement in terms of intelligence are appraised, certain problems associated with the study should be taken into account. In the treatment of the results the three pupil groups were dealt with separately. The factor analytical and transformation analytical investigations carried out revealed structural differences between girls and boys. Thus, this structural variability must be taken into consideration.

The quantification of school achievement differed from that of intelligence in respect to the constancy of the performances. In the quantification of school achievement, measurements extending over two years were employed, whereas measurements obtained in only two situations were used in the quantification of intelligence. It should be taken into consideration, therefore, that in his performances at school an individual may utilize a smaller or larger proportion of his total intellectual capacity. As the writer sees it, the results obtained should be understood in such a way that the school achievement variables also involve a »span» component: a component indicating the proportion of his intellectual capacity that the individual continues to utilize in school situations. The intelligence variables need not necessarily involve such a »span» component. The proportion of an individual's intellectual capacity that is utilized in various situations presents rather complicated problems. Certain recent studies concerning intelligence performances in stress situations suggest that the deterioration attendant upon stress may be different in different performance areas (e.g., Adolfson 1967). Problems worth investigation would be the following: How does the stress experienced in school situations affect the degree of intellec-

tual capacity utilization? And: In what areas of intelligence is the influence of stress strongest? There are problems of the same kind as to the influence of motivation and that of the arrangement of situation.

The operations carried out in the present study were of such a nature that they only indicated linear dependences and linear combinations. This limitation, just as the constancy factor, was present throughout this monograph. It would be advisable, therefore, to take the possibility of curvilinear relationships into consideration in future studies.

When the indices obtained are considered, the composition of the sample of pupils should also be kept in mind: the sample does not include the pupils of the special classes for the mentally retarded, nor does it include those who had passed to secondary grammar school. Hence, a more representative sample might have resulted in different indices.

4. 2. *Shaping Dexterity*

4. 2. 1. *Results*

Previous studies of school achievement and dexterity would have provided an opportunity to advance certain specific hypotheses. Nevertheless, only the following problem Dexterity 1 was formulated for the present study: An attempt should be made to identify the school subjects and the primary factors of school subjects the variances of which are accounted for to an appreciable extent by shaping dexterity.

Inspection of the intercorrelations of the variables (Part II, Tables 26, 27 and 28) reveals that there are several significant correlations between school achievement variables and dexterity variables. Through the operations carried out, this information was given a form easier for interpretation.

The variable-level factor analyses (Part II, Tables 35, 36 and 37) show that, for the girl group, the skill subjects and the dexterity variables jointly form a factor. In the boy group and the combined group the dexterity variables form (in combination with the visual intelligence variables) a factor. The factors in question account for 19 to 14 per cent of the variance of drawing and for 13 to 10 per cent of that of handicrafts. The emergence of the joint factor for the girl group may have partly been due to the number of dimensions chosen for the factor analysis, but it may also reflect the factual state of affairs.

The congruence coefficients (Part II, Tables 43 and 38) permit the conclusion that, in the boy group and the combined group, the theoretical subjects factor is associated with the dexterity factor (the coefficients being .26 and .25 respectively). Moreover, the skill subjects factor for the boy group is related to the dexterity factor.

The variable-level canonical analysis (Part II, Table 59) provides information about the interrelations between skill subjects and dexterity in the girl group.

The structural comparisons through transformation analysis were complicated by the fact that no independent dexterity factor was obtained for the girl group. The factor analysis which included all the test variables other than intelligence variables (Part III, Tables 62 to 67) shows that one factor was spanned in each pupil group by the dexterity variables. The congruence coefficients suggest that the factor for girls and that for boys correspond to each other very closely (the coefficient is .84).

The following interrelations between school achievement and dexterity were

suggested by the significant correlations ($p < .05$) of factor scores (Part III, Tables 74, 77 and 80):

In the girl group the dexterity factor is interrelated with the skill subjects partial factor. The dexterity factor for the boy group is associated with the skill subjects partial factor and the handicrafts factor. In the combined group, dexterity is related to the handicrafts factor and book-keeping factor.

The factor analyses made of factor scores (Part III, Tables 76, 79 and 82) show the following: The dexterity factor for the girl group represents the same dimension as do the mathematical school achievement factor and the visualization and reasoning factor. It should be taken into consideration in the interpretation of this dimension, however, that the dimensions were not allowed to form freely: in computing the factor scores, the interrelations between the variables included in each particular factor analysis were eliminated. On the other hand, the emergence of dimensions had to do with the interdependence of dexterity and intelligence. In the boy group the dexterity factor has a connection with the handicrafts factor and in the combined group with the home economics factor.

The factor-level canonical analyses (Part III, Tables 86, 87 and 88) show the following: In the first axis pair for the boy group, the axis spanned by the skill subjects factor and the home economics factor is accounted for by an axis spanned by the dexterity factor and certain intelligence factors. In the third axis pair, the axis to be described is determined mainly by the handicrafts factor and the descriptive axis by the dexterity factor (in combination with intelligence factors). The second axis pair for the combined group consists of an axis spanned by the book-keeping factor, theoretical subjects factor and handicrafts factor and of a descriptive axis spanned by the dexterity factor, numerical special factor and verbal factor. The information furnished by the canonical analyses is composite in character; nevertheless, it does help to elucidate the associations between dexterity and school achievement.

The operations intended to describe school achievement in terms of shaping dexterity revealed that shaping dexterity is able to account for a considerable proportion of the variances of skill subjects and, in particular, of the variances of handicrafts and drawing. This result is compatible with that obtained by Tuomola (1964) for boys regarding handicrafts. The indices obtained in the present study also suggest that success in home economics has connections with dexterity. Also, there were separate correlation coefficients and composite indices to show the existence of associations between theoretical subjects and dexterity, especially in the girl group. In the case of the indices obtained as linear combinations it is difficult to determine the extent to which the fact that success in theoretical subjects falls on dimensions spanned by dexterity and intelligence was due to the interdependence between dexterity and intelligence.

4. 2. 2. *Discussion*

The area of dexterity which was quantified in the present study was rather narrow. The use of shaping dexterity as a descriptive factor helped to elucidate the specific character of success in various school subjects. In continuation studies it would be appropriate to employ a broader motor area in the description of school achievement.

The interdependence of dexterity and intelligence variables had the consequence that, in

certain operations based on linear combinations, the joint effect of these variables was not capable of decomposition. In the factor-level operations this complication could have been avoided by including the dexterity and intelligence variables in one and the same factor analysis when the factor scores were computed. The existence of such an interdependence has, on the other hand, its advantages as well. Interdependences of this kind are often confronted in the description of various phenomena, and it is necessary then to seek and develop operations in which the interdependences are under control. In the present study, too, experience was gained concerning the mastery of such interdependences within various sets of variables.

When an attempt is made to discover how far the variance of school achievement can be accounted for by dexterity, the following problem of some interest arises: Can the interrelations between dexterity and school achievement be interpreted as being due to primary dexterity ability functions or to functions resting on training and practice? As a matter of fact, both primary ability functions and, especially in adulthood, functions ascribable to practice (Heinonen 1957 and 1964) may underlie the interindividual dexterity differences observed. In continuation studies it would be appropriate to design experimental situations in which the motor functions involved could be split up into two components — a primary ability component and a practice component — and to investigate how these two components are related to school achievement.

4. 3. *Persuasibility*

4. 3. 1. *Results*

No hypotheses concerning the interrelation between school achievement and persuasibility were advanced. Instead, the following problem, Persuasibility 1, was specified: An attempt should be made to identify the school subjects or the primary factors of school subjects whose variance is accounted for to an appreciable extent by attitude-dependent and/or attitude-independent persuasibility. This point will be considered in the following.

A previous structural study carried out by the writer (Niskanen 1964) yielded two persuasibility factors: attitude-dependent persuasibility and attitude independent persuasibility. In all the structural analyses of the present study, a clear-cut attitude-independent persuasibility factor was obtained. On the other hand, there was a tendency for the attitude-dependent persuasibility variables to be loaded on attitude factors. This was partly due to the fact that it did not prove possible to exclude the influence of the original attitudes from the measuring instruments. Also, when a small number of dimensions was employed, the communalities of the attitude-dependent variables were low. It would have been possible to increase the communalities through certain technical expedients, but this might have resulted in the emergence of factors of secondary factual significance, and it would have been more difficult to attain one of the main goals of the study: to represent the information in concise form.

Comparison of the structures for girls and for boys by means of transformation analysis (Part II, Tables 53 to 58) revealed that the attitude-independent persuasibility factors correspond to each other quite closely. The correspondences within the sphere of attitude-dependent persuasibility are weak, judging by the variable-specific indices. According to the transformation matrices, the factors correspond to each other closely (the coefficients exceed .50). The information yielded by the congruence coefficients (Part III,

Table 42) on the correspondence between the structures supports the conceptions based on transformation analysis.

Both the structural investigations included in the present study and the previous investigations of the relevant interrelations (Niskanen 1964) make it advisable indeed to keep the various persuasibility factors separate in the description of school achievement.

Inspection of the correlation matrices (Part II, Tables 26 to 28) reveals that there are a number of significant correlations between the school achievement variables and both groups of persuasibility variables. This suggests that both persuasibility areas should be included in continuation studies for the analysis of interrelations.

When the results of the variable-level factor analyses (Part II, Tables 35 to 37) were considered in Part II, certain specific associations between school achievement and persuasibility were presented. These associations will not be considered in detail at this point, since their interpretation remains open in the following respect: no attempt will be made to determine what proportion of the interrelations between school achievement and persuasibility as revealed by factor analysis is due to interrelations between these variables themselves and what proportion is attributable to the associations of these variables with the other variables involved.

The variable-level canonical analyses (Part II, Tables 59, 60 and 61) show that a number of descriptive vectors are spanned by the persuasibility variables. The information yielded by canonical analysis is of a composite character; and, as was presented in detail in Part II, multicollinearity played such a prominent part in it that no interpretation will be attempted here. The amount of information on the variable-level interrelations between persuasibility and school achievement was not large.

Inspection of the intercorrelations of the factor scores (Part III, Tables 74, 77 and 80) reveals the following:

None of the correlations in the girl group between school achievement factors and persuasibility factors are significant. The skill subjects partial factor for boys is directly related to the attitude-dependent persuasibility factor ($p < .05$); and the handicrafts factor is inversely related to this persuasibility factor (success in handicrafts is related to low persuasibility; $p < .05$).

The factor analyses made of factor scores (Part III, Tables 76, 79 and 82) resulted in the following findings:

The mathematical school success factor of girls is related to the general persuasibility factor obtained for girls. The citizenship-school subjects specific factor is related to the attitude-independent persuasibility factor. No interpretable associations emerged in the boy group or in the combined group when this analysis model was employed. The fact that the correlations of factor scores suggested the existence of some significant interrelations in the boy group, whereas factor analysis failed to do so, has perhaps to do with the small number of dimensions employed. The interrelations that factor analysis revealed in the girl group are attributable to the following: a number of correlations which were not statistically significant manifested themselves in the factor analysis in a manner that was to be taken into consideration in the interpretation.

None of the most important variables involved in the significantly correlated axis pairs of canonical analysis were persuasibility variables.

The above consideration of the relevant indices shows that persuasibility does not account for the variance of school achieve-

ment to a large extent. Resorting to simplification, it can be asserted that persuasibility seems to be directly related to success in theoretical subjects, and in the case of boys, directly related to performance in music and to the skill subjects partial factor and inversely related to success in handicrafts.

4. 3. 2. *Discussion*

The attempted description of school achievement in terms of persuasibility was complicated by certain problems encountered during the study. The following should be mentioned at this point:

When attitude-dependent persuasibility variables were constructed, it did not prove possible to eliminate the original attitude factor itself. Therefore, the possible influence of differences in attitudes must be taken into account in the appraisal of the results.

In the structural analyses, attitude-dependent persuasibility did not form an invariant dimension independent of the group of pupils. Thus, the study of persuasibility should be continued, with the objective of identifying more invariant dimensions.

In his study on persuasibility (Niskanen 1964), the writer considered interrelations between attitude-dependent persuasibility and intelligence, advancing the view that verbal ability might be a common factor underlying both. This verbal aspect played an important role in the measuring instrument constructed for attitude-dependent persuasibility and in the information given to the test subjects. Judging by the same study, attitude-independent persuasibility is not related to intelligence. The results of the present study showing that there is no close association between school achievement and attitude-independent persuasibility suggest that, when attempts are made to interpret interrelations between persuasibility and school achievement, verbal ability is not sufficient in itself to account for the differences found, even though it might be sufficient in the case of attitude-dependent persuasibility. As the writer sees it, his results indicate that a certain proportion of the variance of school achievement can be accounted for by persuasibility. Arguments in support of this view were put forward in the Introduction. Persuasibility, as understood in the present study, forms only a narrow area in the acceptance of information, and thus it could be expected that no strong associations between it and school achievement would emerge. The result makes it appear likely that a study of interrelations between school achievement and a wider area of the adoption of information could be fruitful.

4. 4. *Pupils' Traits as Rated by Teachers*

The way in which the traits in question were constructed was so problematic statistically, that no hypotheses concerning them were presented in advance. A few studies in which trait variables had been dealt with would, however, have been available for purposes of orientation (e.g., Astington 1960; Lavin 1965). The objectives of the study related to the teacher-rating traits were the following:

Objective Trait 1: An attempt should be made to discover what types of traits, as rated by teachers, might be able to account for the variance of school achievement to an appreciable extent. The information obtained on this point should be used for framing hypotheses for continuation studies.

Objective Trait 2: The rating variables should be utilized to elucidate the pupil evaluation process.

Let us first consider Objective T 1. The

teacher-rated traits were excluded from the factor-level operations. This was because the writer's intention was to endeavour to describe school achievement in terms of dimensions that previous behavioural-science studies had shown to be comparatively invariant and that also emerged in fairly similar form in the present study.

This requirement was not satisfied by the teacher-rated traits. Transformation analysis and the factor analyses carried out revealed variability from group to group in the dimensions spanned by these trait variables. Moreover, the writer was not able to find a general interpretation for the dimensions thus spanned. Also, the high intercorrelations of these trait variables suggested the presence of the halo-effect.

Inspection of the correlation matrices (Part II, Tables 26, 27 and 28) reveals that there are several significant correlations between school achievement variables and the teacher-rated trait variables. The interpretation of these correlation coefficients was complicated by the fact that there was no means available to differentiate the actual trait components from the technical rating components.

The factor analyses (Part II, Tables 35, 36 and 37) show the following: In all three pupil groups, two teacher-rated trait variables, viz., attitudes towards work and emotional balance, obtain high loadings on the theoretical subjects factor. In the boy group, a further three trait variables, viz., activity, attitudes towards teachers and attitudes towards peers, have high loadings on the same factor. Moreover, in all three groups, activity and attitudes towards other poeple, in combination with the sociometric variables, are related to success in theoretical subjects. This relationship also manifests itself in the results of the canonical analyses (Part II, Tables 59, 60 and 61).

The considerations related to Objective T 1 can be asserted to show that an effort should be made to obtain more detailed information on interrelations between school achievement and emotional balance. This would be a step towards a closer analysis of the interrelations between personality tests and school achievement. The results also suggest that it might be appropriate to seek to discover interrelations between various attitude areas and school achievement. Moreover, the information obtained with a view to Objective T 1 makes it appear reasonable to subject the interrelations between activity and school achievement to investigation. A promising approach to the investigation of this problem would be teamwork between behavioural scientists and the representatives of physiology, medicine and biochemistry.

Objective T 2, related to the process of rating, will not be considered in detail at this point. It has been discussed by the writer in connection with separate variables, with the interpretation of factors and with the transformation analyses in Part II. Resorting to simplification, the following can be stated: Rating involves a technical component, and it is difficult to analyze the part played by this component in correlations. Certain of the traits rated by teachers could be used to some extent as the criteria against which the validity of other results was estimated. The dimensions spanned by the trait variables were difficult to interpret in a general form. It also turned out that these dimensions were different for the boy group and girl group. The writer supposes, however, that the use of these trait dimensions in the study also yielded meaningful factual information. This information can be employed for purposes of orientation in future studies of school achievement.

4. 5. *Situational Factors*

In the Introduction, a distinction was made between two kinds of situational factors: first, a situation may be experienced by the individual in a variety of ways and, second, the individual can be experienced in various ways in the situation. Attitudinal variables were used to represent the first group of factors and sociometric measurements the second group of factors. These situational factors will be discussed in the following sections.

4. 5. 1. *Attitudes*

A hypothesis and a problem related to the description of school achievement in terms of attitudes were formulated. Hypothesis Attitude 1 was as follows: A positive attitude towards the communicator is likely to be associated with good school achievement. Problem Attitude 2 was specified in the following way: An attempt should be made to discover which attitude variables are capable of accounting for the variance of school achievement to an appreciable extent.

The correlation matrices (Part II, Tables 26, 27 and 28) show the following. There are significant correlations between attitudinal variables and school achievement variables. Space does not permit a detailed consideration of these correlations.

From the factor analyses (Part II, Tables 35, 36 and 37) it may be concluded that there is a tendency for the attitude variables to span a limited number of dimensions. Only a single clear-cut attitudinal dimension emerged in the present study; judging by the transformation indices and congruence coefficients, this dimension is fairly invariant under alterations in the group of subjects. The writer has also found in his previous studies that, when Likert-type measuring instruments are employed in the study of attitudes, without decomposition, the number of emerging dimensions is small (Niskanen & Takala 1964; Niskanen 1964). Heikkinen's (1962) investigations have yielded similar results.

The factor analyses also furnished information on the interrelations between attitudinal and school achievement variables. The results show that positive attitudes towards teachers obtained, in each pupil group, a loading on the skill subjects factor that is high enough to be taken into consideration in interpretation. Moreover, in the boy group a negative attitude towards peers is related to success in penmanship.

The variable-level canonical analyses (Part II, Tables 59, 60 and 61) reveal that, in the case of several pairs of vectors which correlated significantly with each other, attitudinal variables are among those that spanned the descriptive vectors. Because of the problems connected with the interpretability of this analysis model, these vector pairs will not, however, be discussed in greater detail at this point.

The intercorrelations of factor scores (Part III, Tables 74, 77 and 80) reveal the following: In the girl group the attitude factor is related to the skill subjects partial factor (the correlations which were significant at least at the .05 level were regarded as interpretable). In the boy group the attitude factor is related to the theoretical subjects factor and the skill subjects partial factor. The intercorrelations of factor scores do not reveal any significant interrelations between the attitude factor and school achievement factors in the combined group.

The factor analyses made of factor scores indicate that, in each pupil group, the attitude factor is associated with the partial skill subjects factor (Part III, Tables 76, 79 and 82).

The factor-level canonical analyses yielded no significantly correlated axis pairs indicative of associations between an attitude factor and school achievement factors.

Hypothesis A 1 found only partial confirmation in the results obtained. In all three pupil groups, positive attitudes towards the source of information seemed to be related to success in skill subjects. A similar relationship between attitudes and success in theoretical subjects, and merely a weak one, was only ascertainable for the boy group.

Information relevant to Problem A 2 was also put forward in the preceding section, dealing with the traits of the pupils as rated by teachers. In that section, results concerning attitudes towards other people and work were reported. It was possible to show that these variables had associations with success in theoretical subjects. The interrelations ascertained to exist between attitudes and school achievement can be interpreted starting from either the pupil evaluation process or motivational factors. Previous studies concerning attitudes and school achievement indicate that the interrelations between these variable groups are different in the case of different school subjects. Aiken & Dreger (1961), for example, demonstrated the existence of associations between success in mathematics and attitudes. Biggs (1959) in turn showed that success in mathematics is associated with attitudes more closely than is success in the English language. He also obtained results suggesting that the relationship was not linear. As regards the interpretation of the present study, it should be kept in mind that, owing to the procedures employed, only linear relationships can be ascertained. In continuation studies, attention should be paid to the possibility of curvilinear relationships, and use should be made of more narrowly circumscribed objects of attitudes.

4. 5. 2. *Discussion*

The use of attitudinal variables in the description of school achievement revealed that these variables have a certain function to perform here. In continuation studies, an attempt should be made to distinguish a further differentiation of attitudes. In recent times, efforts have been made to distinguish various components in the field of attitudes. The present writer has treated these issues in an article concerned with the establishment of attitudinal variables (Niskanen 1964). Other Finnish investigators have also treated the sphere of attitudes from a theoretical standpoint, and attempts have been made to identify various components of attitudes in empirical situations (e.g., Karvonen 1967). Progress in the study of attitudes will also enable one to seek to describe school achievement in terms of more differentiated attitudinal variables.

In the present study, the question concerning the part played by the pupil evaluation process in the emergence of interrelations between attitudes and school achievement remained open. This is one of the problems that should be solved in continuation studies.

The data secured by the present writer could be employed *per se* for investigating the possible curvilinear relationships between school achievement and attitudes. No such attempt will be made in the present study, however, but the writer merely confines himself to the study of linear relationships.

4. 5. 3. *Sociometric Variables*

The second group of situational factors included in the present study was formed by sociometric variables. The following hypotheses and problems concerned with the

interrelations between school achievement and sociometric variables were formulated by the writer:

Hypothesis Sociometric 1: Leadership is capable of accounting for a proportion of the variance of school achievement.

Hypothesis Sociometric 2: Companionship is capable of accounting for a proportion of the variance of school achievement.

Problem Sociometric 3: An attempt should be made to obtain detailed information as to the individual school subjects or the primary factors of success in various school subjects the variances of which can be accounted for to an appreciable extent by the leadership or companionship variables or by the primary factors of sociometric variables.

The hypotheses and the problem seem to be partly overlapping. This is because the structure of the area of sociometric variables has not been investigated so far: the writer could find no studies in which several leadership and companionship variables were subjected to structural investigation. This problem has not been studied, even though it was dealt with by Koskenniemi, for example, as early as 1943. In the present study, the sociometric variables formed a factor, in combination with activity and the attitudes towards other people, or they formed a dimension of their own. Judging by the transformation indices and congruence coefficients, the sociometric dimensions obtained for the different pupil groups corresponded quite closely to one another. The interpretation of the sociometric dimensions becomes problematic if interpretations having general validity are aimed at. Another fact also complicates interpretation: the variables were considered over classes, and this procedure is suitable only where general information of a crude kind is being sought. In the following, the results yielded by the various operations will be presented, after which the hypotheses and the problem will be considered.

Inspection of the correlation matrices (Part II, Tables 26, 27 and 28) reveals that there are a number of significant correlations between school achievement and sociometric variables.

The variable-level factor analyses and the congruence coefficients show that, in the boy group and the combined group the sociometric variables have associations with the theoretical subjects factor (Part II, Tables 35, 36 and 37; 38 and 43). When the information based on the congruence coefficients is employed, it should be noted, however, that activity and attitudes towards other people are also involved in the sociometric factors.

The canonical analyses (Part II, Tables 59, 60 and 61) reveal that the sociometric variables span several descriptive vectors. These will not, however, be discussed in detail, owing to the composite character of the information furnished by these analyses.

The factor-level correlations and factor analyses (Part III, Tables 74, 76, 77, 79, 80 and 82) show the following:

The sociometric factor for the girl group is related to the theoretical subjects factor ($p < .05$). In the boy group and the combined group the sociometric factor is associated with the theoretical subjects factor and the skill subjects partial factor.

The canonical analyses revealed that, in the second axis pair for the boy group ($p < .001$) the sociometric factor contributes to span, in combination with intelligence factors, a vector descriptive of success in theoretical subjects (Table 87).

The leadership and companionship variables were so closely interrelated that the operations performed did not furnish much information in support of Hypothesis So 1 or Hypothesis So 2. On the other hand, the information

relevant to Problem So 3 can be presented, in simplified form, as follows: In all three pupil groups, the sociometric variables account for a considerable proportion of the variance of the success in theoretical subjects; in the boy group, moreover, they also account for the variance of the success in practical subjects to an appreciable extent.

4. 5. 4. *Discussion*

Little information relevant to the hypotheses advanced was obtained in the present study. If only one of the two sociometric variables, either leadership or companionship, had been included in the operations, information of such a kind might have emerged. This would have been quite laborious, however, and was given up by the writer.

A particular problem encountered when the sociometric variables were employed with the objective of accounting for the variance of school achievement was concerned with the justification of the operations over classes. The same problem was, however, also met in other context: the general line of approach in the study implied the use of such operations. From a factual, though not from a formal, point of view it would have been more appropriate to keep the school classes separate. Yet, the operations would have been more laborious and the groups of pupils would have been too small to justify the application of multidimensional operations. Hence, the operations undertaken to reduce the number of dimensions would have been unfounded. To be sure, during the years when work on this study was in progress, procedures were developed through which operations over classes could have been avoided. In the case of the sociometric variables this could have been accomplished by employing the principle of equilateral triangles, introduced by Coleman (1961), in constructing the variables. The operations concerned with the entire set of variables again could have been made class-specific by employing the partial-group analysis developed by Heinonen (1968). By means of this method it would have been possible to fix and sense the configuration for the entire group of subjects and then to perform the operations pertaining to each subgroup within the framework of a configuration already determined; this procedure would have been made it possible to diminish the variance encountered in the establishment of configurations for small samples.

4. 6. *Background Variables*

4. 6. 1. *Social Status*

The following Problem Status 1 concerning interrelations between social status and school achievement was formulated by the writer: Which are the school subjects the variance of which can be accounted for to an appreciable extent by social status?

Social status was included only in the variable-level operations. It was excluded from the factor-level operations owing to the fact that the variable-level operations failed to indicate any dimension, within the framework of the present battery, that it would have clearly represented.

The variable-level correlations (Part II, Tables 26, 27 and 28) reveal the following: In the girl group, social status correlates with success in theoretical subjects (those whose social status is high are successful in theoretical subjects). In the boy group, social status correlates only with the marks for religion (those whose social status is low tend to obtain high marks in religion). The present study suggested that social status is not an

effective predictor of school achievement, as far as boys are concerned; the result for the girl group was similar to that reported by Mäki (1961). Yet, the studies surveyed in the Introduction suggest the existence of associations between social status and school achievement. The writer supposes, therefore, that it might be useful to employ a social status variable based on a number of various components and not on parents' occupation alone. Previous studies also indicate that the strength of the connection between social status and school achievement may depend on age, sex and school type (e.g., Husén et al. 1959, Mäki 1961). The study of the relationship between social status and school achievement should be continued by employing various groups of pupils.

4. 6. 2. *The Number of Siblings*

The following Problem Sibling 1 concerning interrelations between the number of siblings and school achievement was formulated by the writer: Which are the school subjects the variance of which can be accounted for to an appreciable extent by the number of siblings? The number of siblings was included only in variable-level operations. Inspection of the correlation matrices (Part II, Tables 26, 27 and 28) reveals the following: In the girl group, a small number of siblings is associated with high marks in theoretical subjects. (Three of the relevant correlations are statistically significant.) In the boy group, a large number of siblings is associated with high marks in skill subjects. (Four of the correlations are significant.) Moreover, a small number of siblings is associated with high marks for mathematics and civics.

The number of variables related to the home was small in this study. Social status and the number of siblings were the only variables of this kind. The results suggest, however, that it is advantageous to include variables related to the pupil's home in studies aiming at the description of school achievement. As the writer sees it, investigation elucidating the process through which school achievement is influenced by the home would be called for.

5. DISCUSSION

The study had both empirical and methodological goals. The extent to which the empirical goals were achieved was discussed in the sections that reported the results concerning the structure of school achievement and those related to the description of school achievement in terms of a number of other variables. Similar appraisals regarding the methodological goals were presented in connection with the relevant methodological operations. The rather plentiful information obtained was considered by the writer only in so far as it was relevant to the hypotheses advanced or the problems and objectives specified. In consequence, information of considerable interest — e.g., information on interrelations between descriptive variables — was disregarded here, and the writer intends to consider it later in separate articles. Also, the writer did not undertake many com-

parisons between the results of this study and those of previous studies. This was not only because of the large number of results, but also because of the absence of an adequate theoretical framework for comparisons: in the behavioural sciences, little attention has so far been devoted to the development of such a framework. Nummenmaa (1965) has put forwards views on how such comparisons could be made increasingly accurate. Had comparisons been included in the present study, it would first have been necessary to undertake a rather thorough appraisal of the studies to be compared with this one. Space did not permit doing so, however.

In the Introduction, the acquisition of knowledge concerning educational phenomena and the presentation of recommendations concerning the procedures to be employed were asserted to be the general goals of educational research. The present study yielded information on school achievement behaviour, as measured in terms of the marks given by the teacher. This information can be utilized in advancing recommendations regarding the evaluation of pupils by teachers. The results of the structural analysis of success in various school subjects can be used as a foundation for procedural recommendations. Music, for example, was discovered to be a comparatively specific school subject as regards the evaluation of the pupil's achievement. By contrast, the marking proved to be relatively undifferentiated in the case of several theoretical subjects. In this study, the teachers were also requested to rate the pupils in a number of personality traits, and the information obtained on interrelations between these traits and school achievement can be utilized to make inferences regarding the extent to which the various functions to be evaluated are coloured one by another. The results also permit advancing practical recommendations concerning the arrangement and organization of instruction. Results on interrelations between sociometric variables and school achievement, for example, were reported in this study. These results suggest that arrangements through which the pupils' sociometric positions can be altered are also likely to end in changes in their school achievement. One must, of course, be careful not to put forward recommendations that do not find sufficient support in the results. To be able to present more far-reaching recommendations, one should possess more information obtained through the study of individual school classes and individual pupils, as well as information concerning the processes that underlie the interrelations discovered.

One of the goals of the present study was to find out how far the variance of school achievement could be accounted for by a number of variables chosen for the purpose. This part of the study was related to the problems of explanation and description, which have been extensively discussed in the theory of science. The writer has no intention to delve at this point into the question concerning the distinctive characteristics of causal and finalistic explanations and of description. However, in the behavioural sciences, in particular, explanation and description lead to problems concerning the nature or »essence» of the phenomena in question. In discussing causal explanations based on motives, von Wright (1966) asserts that such explanations cannot be anything but reformulated finalistic explanations. Why is such a situation encountered in the explanation of the phenomena dealt with by the behavioural sciences? As the present writer sees it, what is concerned is not exclusively the formulation of the explanations; instead, the problem is associated with the fact that neither the factors to be explained nor the explanatory factors are known and

that it is even difficult to imagine that the phenomena to be explained and the explanatory phenomena could be completely independent. Let us suppose that we endeavour to explain a mode of behaviour A in terms of a mode of behaviour B. What is the relationship between A and B? When an answer is being sought to this question, we are dealing with the phenomena A and B the inward nature of which we do not know. Thus, in a sense, we try to explain an unknown by another unknown. Moreover, the fact that A and B cannot be rendered independent, in principle, boils down to this: what we attempt to do is to explain a phenomenon by itself. How, then, is it possible for behavioural research to progress towards explanatory or descriptive investigation? Diversified studies on various behavioural areas yield information concerning behavioural functions. As a result, the functions become increasingly less unknown, and they are rendered increasingly suitable for use as factors to be explained and as explanatory factors. The primary interdependence of the two kinds of factors entails, in turn, that a behavioural scientist, being aware of this interdependence, defines the difference and attempts to discover the probabilities involved in the interrelations. The probabilities will be incorporated into models, theories and laws.

How can the empirical investigations reported here be related to the line of approach characterized above? To be able to cope with the problem arising from the fact that the factors dealt with are unknown, the writer included in the set of independent variables a number of factors on which previous studies were available. In the construction of the descriptive design, a starting point was formed by the fact that the differences between the dependent and independent variables may be defined either on the basis of differences in coverage or on the basis of differences in behaviour. The factors defined as different made it possible to construct a descriptive framework. Only an attempt was made in the present study to integrate the results at a theoretical level. In point of fact, the proximate goals for the investigation of school achievement should include a theoretical and empirical exploration of the general laws governing school achievement behaviour.

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